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ABSTRACT

Evidence regarding the centrality of word recognition to the reading process is considered, based on a review of research on beginning reading from 15 secondary sources. The research includes diverse learners who are low performers, learning or reading disabled, remedial readers, high achievers, culturally disadvantaged, language delayed, and linguistically diverse. The characteristics, contexts, and conditions of learners and learning are discussed. Evidence from a variety of models and frames of reference in beginning reading research is presented, including cognitive, instructional, and educational psychology; linguistics; and special education. Four areas of convergence from the studies reviewed are identified, with implications for word recognition: reading comprehension is dependent on strong word recognition skills; strong word recognition requires understanding that words can be spoken or written, print corresponds to speech, and words are composed of phonemes; alphabetic understanding facilitates word recognition; and phonological recoding combined with word frequency mediates word recognition. A chart identifies study author(s) and year, number and type of study participants, the beginning reading dimension, and the purpose of the study. (Contains 27 references.) (SW)

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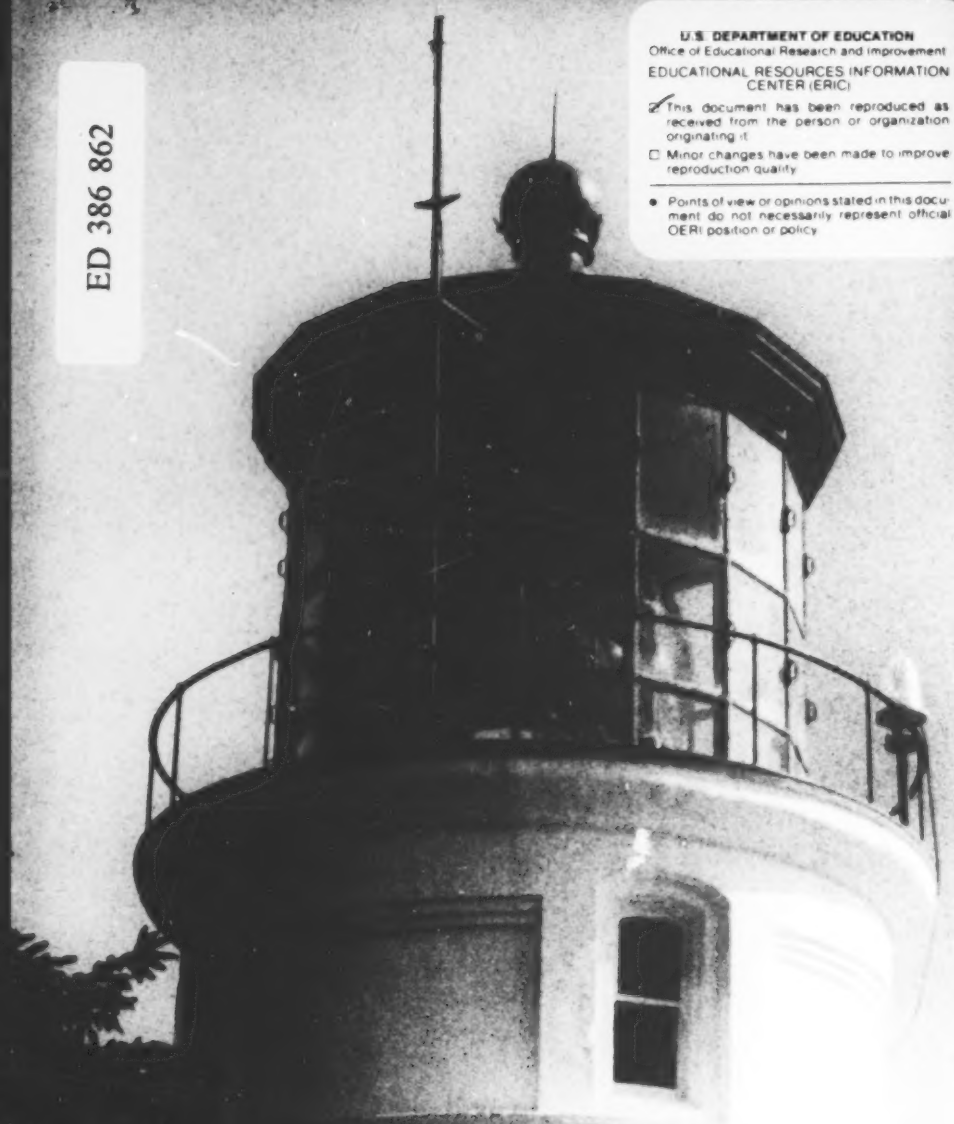

National Center to Improve the Tools of Educators

College of Education
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Understanding the Primary Role of Word Recognition in the Reading Process: Synthesis of Research on Beginning Reading

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Understanding the Primary Role of Word Recognition in the Reading Process: Synthesis of Research on Beginning Reading

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Running Head: WORD RECOGNITION

Understanding the Primary Role of Word Recognition in the Reading Process: Synthesis of Research on Beginning Reading

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Despite popular perception that reading is acquired as naturally as spoken language, there is overwhelming evidence that growing numbers of Americans fail to become functionally literate. In addition to the unfortunate trend of increasing illiteracy, links between illiteracy and other societal difficulties are clear. For example, the Orton Dyslexia Society (cited in Adams, 1990) reported that adults without basic literacy skills accounted for 75% of the unemployed, one third of mothers receiving Aid to Families with Dependent Children, and 60% of prison inmates. Meanwhile, illiterate youth represent 85% of juveniles appearing in court. Together, these correlates suggest that the cost of illiteracy is tragic and long lasting both in human and economic terms.

Juel (1991) asserted that the urgency created by adult illiteracy may have contributed to our lack of knowledge of the reading process. That is, poor performances by older students on national assessments of higher order reading and writing shifted the focus of research from beginning reading to more higher order reading processes such as comprehension strategies. In concentrating on reading and writing at higher levels, research and practice research and practice has largely ignored individual differences in reading acquisition (Juel, 1991). Yet, converging evidence (Daneman, 1991; Juel, 1991; Stanovich, 1991, 1993/1994) indicates that individual differences in early reading are most responsible for the variation in performance between mature readers and beginning readers. In short, the overriding difference between readers and pre-readers is their ability to read words.

Word recognition refers to linking the printed representation of a word with its meaning (Stanovich, 1991). Understanding the particulars of word recognition is important for two reasons. First, higher order reading skills such as comprehension, vocabulary development, and purposeful, enjoyable reading and writing are dependent on accurate word recognition (Stanovich, 1991). Second, word recognition is central to reading acquisition (Daneman, 1991; Juel, 1991;

Stanovich, 1991). Consider the following analogy. The reading process can be likened to the sport of mountain climbing. The trip up a mountain is difficult and strenuous for some climbers while others are less challenged. These differences may be a result of the climbers' conditioning and experience in climbing, their familiarity with the mountain, and/or their starting point, and the tools with which they are equipped. Regardless of these differences, every climber experiences the location on the mountain that becomes the "crux" of the climb, the critical place on the mountain where passage assures a successful climb. Some climbers, the crux cannot be negotiated on the first attempt, but experience and practice on the terrain result in eventual success. For other climbers, the crux may be negotiated on the first pass. Yet other climbers may experience failure in attempting the crux and reject climbing altogether. Despite the challenge posed by a particular section of the climb, the goal is not to negotiate the crux, but to arrive at the summit and enjoy the view.

Likewise, learning to read is a complex activity. As with mountain climbing, some readers find the task more complex than others. Learning to read is mediated by a variety of skills related to language development (e.g., print awareness, phonological awareness). Beginning readers approach learning to read with differential levels of these mediating skills or "tools" necessary for reading acquisition. For example, some children may have the necessary tools to begin reading as a result of being raised in literature-rich environments. Still others may be unfamiliar with the tools and may struggle without support or direct guidance. For all readers, the "summit" of reading acquisition is independent reading resulting in clear communication, strong reading comprehension, articulate writing, critical analysis skills, and more. Before reaching the reading summit, however, every reader must recognize words; that is, the reader must identify (encode) the word, translate the printed word into its corresponding sound

(phonologically recoding), and access the word's meaning (lexical access). Quite simply, word recognition is the "crux" of reading (Daneman, 1991; Stanovich, 1991).

Methodology

Sources

Our review of research included 14 secondary sources (Adams, 1990; Daneman, 1991; Ehri, 1991; Juel, 1991; Liberman & Liberman, 1990; Liberman, Shankweiler, & Liberman, 1991; Spector, 1995; Stahl & Miller, 1989; Stanovich, 1991; 1993/1994; Sulzby & Teale, 1991; Torgesen, 1985; Wagner, 1986; Wagner & Torgesen, 1987) and 10 primary studies (Byrne & Fielding-Barnsley, 1989; Haskell, Foorman, & Swank, 1992; Lovett, Warren-Chaplin, Ransby, & Borden, 1990; Lundberg, Frost, & Petersen, 1988; Sawyer, 1992; Sindelar, Monda, & O'Shea, 1990; Spector, 1992; Vellutino & Scanlon, 1987; Weinstein & Cooke, 1992; Weir, 1989). The 15 secondary sources included 11 descriptive narratives, three descriptive analyses, and one quantitative research synthesis. The descriptive secondary sources included five book chapters and one book. More detailed information about each source is provided in Tables 1 and 2.

Insert Tables 1 and 2 about here

Subject Characteristics

Participants in the research reviewed here included students identified as general low performers, students with learning or reading disabilities, remedial readers not considered to have learning disabilities, high achievers, and culturally disadvantaged, language delayed, and linguistically diverse students. In terms of age, subjects ranged from preschoolers to eighth graders; however, the majority of studies focused on kindergarten and first grade. With the exception of one primary study (Lundberg et al., 1988), studies targeted English-speaking subjects.

Summarization of Methodology

Two independent reviews of each source were conducted. Responses were grouped under three categories: (a) general conclusions, (b) learner characteristics, and (c) instructional implications. Convergence within the categories was achieved through a multiple-step process. Reliability was achieved through a process that combined independent reviews, inter-coder comparisons of data categorization, coding clarification, and refinement with reliability checks on all sources. The primary author of this chapter used the convergent responses from the review and the coding process in concert with a second examination of each source to derive general areas of convergence.

Definitions

Word recognition, the central focus of this chapter, refers to the process of seeing a word and accessing its meaning. Several definitions will facilitate the detailed discussion of word recognition that follows. *Phonological awareness*, a critical prerequisite to word recognition, is the understanding that words are composed of sounds. Another prerequisite to word recognition, *alphabetic understanding*, is the understanding that words are composed of individual letters and that these letters correspond to sounds. Phonological awareness and alphabetic understanding combine to form a broader construct, the *alphabetic principle* or *alphabetic insight*. Automatic word recognition begins with *phonological recoding*, the process of translating words into their phonological counterparts using letter-sound rules. For example, the word "man" would be converted into its component letters (m, a, n), then into its corresponding sounds (/m/, /a/, /n/) and blended into its phonological referent to the word "man." Finally, this phonological referent can be used for *lexical access* of the word's meaning. That is, it can be matched with a definition held in the reader's mental dictionary. Throughout our discussion we will repeat these definitions for clarity.

Chapter Overview

The intent of this chapter is to identify and discuss areas of converging evidence regarding the centrality of word recognition to the reading process. The characteristics, contexts, and conditions of learners and learning are discussed based on data and conclusions from the research on beginning reading. Research on beginning reading is very technical and focuses on models that explain the process of word recognition. We have attempted to distill evidence that cuts across a variety of models and frames of reference in beginning reading research including cognitive, instructional, and educational psychology, linguistics, and special education. Each general area of convergence regarding the reading process and word recognition proceeds from a discussion of the general development of skilled readers to the unique experiences of students with diverse learning needs. Available research on interventions are also reviewed. Some general areas of convergence do not contain subsections on diverse learners or interventions because of a lack of relevant research. Figure 1 represents a graphic depiction of the chapter's structure.

Insert Figure 1 about here

General Areas of Convergence

Our review of the beginning reading literature provided evidence on the development of word recognition skills and the importance of word recognition to reading acquisition and higher order reading activities. The four general areas of convergence from the studies reviewed for this synthesis are:

- Comprehensions processes and word recognition skills.
- Prerequisite conditions of word recognition.
- Alphabetic understanding.

- Word recognition mediated by phonological recoding.

Area of Convergence #1: Comprehension Processes and Word Recognition Skills

Readers appear to differ in the ease with which they achieve deeper levels of understanding (Daneman, 1991). These differences in the comprehension of meaning are important, however, the dependence of reading comprehension on fluent word recognition cannot be ignored. Comprehension of subtle language concepts and relationships are not dependent on word recognition skill until the reader tries to comprehend those concepts and relationships as they are communicated in print. Indeed, word recognition skills lead to improved reading comprehension ability rather than the reverse (Daneman, 1991; Juel, 1991; Stanovich, 1991). According to Stanovich (1991), if fluent word recognition does not produce a clearly identified word in working memory, "comprehension processes do not have the raw materials to operate efficiently and understanding of text will be impaired" (p. 443). Consider the following altered passage suggested by M. Sprick (personal communication, May 5, 1994) which simulates reading at 80% accuracy:

> He had never seen dogs fight as these w__ish c___ f____t, and his firs ex_____ t____t him an unf_____able l_____n. It is true, it was a vi_____ ex_____, else he would not have lived to pr_____it by it. Curly was the v_____. They were camped near the log store, where she, in her friend__ way, made ad_____ to a husky dog the size of a full-_____ wolf, th____ not half so large as _he. __ere was no w_____ing, only a leap in like a flash, a met_____ clip of teeth, a leap out equal__ swift, and Curly's face was ripped open from eye to jaw.
>
> It was the wolf manner of fight__, to st___ and leap away; but there was more to it than this. Th__ or forty huskies ran _o the spot and not com_____d that s_____t circle. Buck did not com_____d that s_____t in_____, not the e___ way with which they were licking their chops. Curly rushed her ant_____, who struck again and leaped aside. He met her next rush with his chest, in a p_____ fash___ that tum___ed her off her feet. She never re_____ed them. This was __at the on_____ing huskies had w_____ for. (London, 1981, p. 55)

Fluency is a combination of accuracy and reading rate. As illustrated by the effort required to read the above passage, even a small percentage of words, if not read accurately, will slow the reader and create gaps in understanding. Although much of the story can be gleaned from this passage, as it stands, clearly, more recognized words would produce a stronger image and, perhaps, a greater chance of it being understood and remembered. Thus, word recognition fluency, while not the goal of reading instruction, is necessary for good comprehension.

Areas of Convergence for Skilled Readers

A description of the complex process of reading comprehension development is beyond the scope of this research review. However, converging evidence suggests that the extent to which reading comprehension is dependent on word recognition varies with the level of reading development. Specifically, normal achievers' comprehension at approximately the end of first grade, appears to be strongly affected by word recognition. Sawyer (1992) argued that comprehension's early dependence on word recognition may indicate that facility with the orthographic code (i.e., the printed symbols that represent the letters of the alphabet) is the "principal barrier" to comprehension in the first grade. This barrier posed by orthography is probably a function of early readers' focus on graphic cues, letter-phoneme or sound correspondences, and smooth sound blending to encode words that may or may not be a part of their limited vocabularies (Ehri, 1991).

In contrast, once readers achieve a degree of familiarity with the code (generally, sometime after first grade), comprehension seems to have a large direct effect on their word recognition (Sawyer, 1992). For example, readers who have learned the correspondence between letters and sounds may begin to associate certain letter patterns and whole words with their meanings. As their decoding ability becomes more fluent and letter patterns and words become more familiar, skilled readers get better and better at changing clauses or whole sentences into their

language equivalents and then holding them in their original form (Adams, 1990). That is, they are able to change the coded (written) words into their corresponding language. Even after skilled readers access a word's meaning, they continue to recode the word from its written to its phonological form. Reportedly, this action helps the reader maintain the word's meaning in short-term memory and facilitates reading comprehension (Baddeley, reported in Adams, 1990). Thus, it seems that good word decoders comprehend more; and as expected, stronger comprehension enhances a reader's ability to decode and hold clauses or whole sentences in working memory.

Areas of Convergence for Diverse Learners

Not surprisingly, less skilled readers' comprehension continues to be highly dependent on word recognition skills (Stanovich, 1991). In part, this is due to the relation between the translation of written words into their spoken (phonological) representations, word recognition, and the subsequent storage of the meaning of sentences or clauses in short-term memory. The amount of assistance readers receive from their ability to translate written words to phonological representations varies directly with the speed with which items to be remembered are encoded (Baddely, Thomson, & Buchanan; Case, Kurland, & Goldberg; Dempster; cited in Adams, 1990). Poor and young readers who are not yet facile at processing letters and sounding out words fail to recode words in meaningful groups and, therefore, are less likely to maintain the meaning of a clause or sentence in short-term memory (Adams, 1990). In effect, readers who are less able to generate high-quality phonological representations as a part of word recognition are at a disadvantage and at-risk for memory loss (Daneman, 1991). Thus, poor word recognition appears to limit (a) storage of and access to word meanings and (b) ability to access or remember sequences of words.

Once again, our emphasis on reading comprehension's dependence on word recognition is not intended to minimize the significance of reading comprehension. Any comprehensive review of the reading process must address differences in readers' ability to comprehend and understand the message in the print, as well as their ability to recognize words from print.

Areas of Convergence #2: Prerequisite Conditions of Word Recognition

Having investigated the relation between word recognition and the goal of reading, we step back to consider factors that appear to facilitate beginning word recognition. Juel (1991) noted that children who are nearly ready to begin reading words have developed four prerequisite skills. Specifically, they understand that (a) words can be "spoken" or "written," (b) print corresponds to speech, (c) words are composed of phonemes (sounds), and (d) words are composed of letters that correspond to phonemes. Although these conditions are not necessary for children to begin formal reading instruction, abundant evidence suggests they facilitate learning to recognize words. In the following section, we discuss briefly children's understanding of the communicative function of print and phonological awareness.

The first two conditions necessary for word recognition, recognizing the existence of words in print and in speech and understanding that print is encoded speech, are most likely nurtured as children are read to or observe others reading. Informal interactions between children and their parents during story reading help familiarize children with print and its conventions such as left-to-right directionality, punctuation, and page formats (Stahl & Miller, 1989). Sulzby and Teale (1991) referred to these conditions as understanding the communicative function of print. In a review of early literacy research, Weir (1989) found that children as young as three years show understanding of the social uses of written language, print conventions, and an ability to interact with print (see Gunn et al., this volume).

The third condition necessary for word recognition, phonological awareness (i.e., understanding that words are composed of sounds), is discussed in detail in the chapters on emergent literacy and phonological awareness (this volume). Therefore, we will not discuss areas of convergence for skilled readers and diverse learners or phonological awareness interventions. However, a brief discussion of phonological awareness and its relation to word recognition is provided to reinforce the relation between phonological awareness and word recognition.

Phonological awareness has been defined in a number of ways. Spector (1992) referred to it as the ability to perceive spoken words as a sequence of sounds. Alternatively, Wagner and Torgesen (1987) defined phonological awareness as the awareness of and access to the sounds of language. While a single definition is elusive, it is clear that phonological awareness is inextricably coupled with beginning reading. Thus, research over the past 15 years has validated repeatedly the importance of phonological awareness to reading acquisition (see reviews by Adams, 1990; Ehri, 1991; Juel, 1991; Spector, 1995; Stanovich, 1993/1994; Wagner & Torgesen, 1987). Yet it remains debatable whether phonological awareness is prerequisite to word recognition, or whether it is interactive and, therefore, is augmented by word recognition.

A child with phonological awareness is aware of the internal phonological structure of words (Liberman, Shankweiler, & Liberman, 1991). Practically speaking, this means the child is aware that (a) spoken words are made up of individual sounds, (b) sounds can be blended into words, and (c) the same sounds may be found in different words (e.g., m in man and m in rim). Emergent readers enter formal reading instruction with differential awareness of words' phonological structure. However, as Juel (1991) pointed out, "some form of phonological awareness is necessary for successfully learning to read alphabetic languages" (p. 778). In fact, Juel, Griffith, and Gough (cited in Juel, 1991) reportedly found that most children

who could not decode well in first grade had entered school with little phonological awareness.

Our description of phonological awareness is simplified for purposes of clarity and should not be interpreted as diminishing its importance. Phonological awareness is not a self-contained skill that is mastered in isolation. To the contrary, we discuss phonological awareness as preceding word recognition because its phonological basis makes it well suited for development during early language learning.

Researchers have attempted to distinguish phonological awareness from one of its more specified components, phonemic awareness. While phonological awareness implies a broader understanding of the connection between words and sounds, phonemic awareness is "the ability to deal explicitly and segmentally with sound units smaller than the syllable" (Stanovich, 1993/1994, p. 283). Therefore, phonemic awareness differs from phonological awareness in its degree of specificity. A detailed description of phonemic awareness, its relation to phonological awareness, and its role in word recognition are beyond the scope of this chapter but are discussed by Smith et al., (this volume). In the next section, we describe how the awareness of sounds in words is linked to print and ultimately to understanding our alphabetic language.

Area of Convergence #3: Alphabetic Understanding

Converging evidence about the fourth prerequisite to word recognition, alphabetic understanding, warrants its own discussion. Alphabetic understanding refers to a child's understanding that words are composed of individual letters (graphemes) and "the use of grapheme-phoneme relations to read words" (Ehri, 1991, p. 387).

Alphabetic understanding is concerned with the "mapping of print to speech" and establishing a clear link between a letter and a sound. It is not enough that a

child knows each letter and can point to or print each one, but as Adams (1990) stated,

> Very early in the course of instruction, one wants the students to understand that all twenty-six of those strange little symbols that comprise the alphabet are worth learning and discriminating one from the other because each stands for one of the sounds that occur in spoken words. (p. 245)

Liberman and Liberman (1990) concluded that preliterate children are not very aware that words are formed by letters of the alphabet, but those who have alphabetic understanding perform predictably superior to those who have less.

Areas of Convergence for Skilled Readers

Children's responses to words differ qualitatively before and after they master letter-sound correspondence. Gough, Juel, and Roper-Schneider (cited in Juel, 1991) found that first graders without letter-sound knowledge made more errors than their peers who had mastered letter-sound correspondence. Moreover, errors made by the children with letter-sound knowledge were most often caused by improper "sounding-out" of the word. In contrast, children without letter-sound knowledge tended to substitute words that they saw often in their book. In short, students who had not learned the correspondence between letters and sounds guessed at words based on first sounds, physical features of the words, or context.

Interventions for Teaching Alphabetic Understanding

Is alphabetic understanding critical enough to warrant explicit teaching of letter-sound correspondence to beginning readers? Juel (1991) cited eight studies that provide considerable evidence of the importance of alphabetic understanding in accounting for differences between good and poor readers. Similarly, in a recent investigation, Haskell et al. (1992) found that students who received explicit training in letter-sound correspondence either at the onset-rime (e.g., /b/ - /at/ is "bat" a la Sesame Street) or at the phoneme level (e.g., /b/ - /a/ - /t/ is "bat") were more

accurate on a word recognition test consisting of regular and irregular words than students who received whole word training or no training.

Lovett et al. (1990) compared the effects of explicit training of letter-sound correspondence in word recognition with whole word training in word recognition with readers with disabilities. Children with severe reading disabilities more than doubled the number of regular and irregular words they could identify on instructed word lists after receiving either letter-sound or whole word training. While the results of this study were positive, the investigators reported that neither treatment group showed posttest advantage on uninstructed words, untaught rhymes, or pseudoword (i.e., words that conform to rules of phonics, but have no meaning) recognition. Lovett et al. (1990) suggested the subjects might have lacked the ability to segment syllables in words and, therefore, were unable to acquire or apply rules or analogies to reading.

Other studies have investigated the effects of letter-sound correspondence as part of an intervention on language and reading skills. In a series of experiments studying the relation between phonological awareness, letter-sound correspondence, and word recognition, Byrne and Fielding-Barnsley (1989) found that young children can read by analogy (i.e., begin to process new words by recognizing the same word parts found in familiar words) if they know (a) that phonemes are separate segments in words, (b) that the same phonemes can occur in different words, and (c) letter-sound correspondences. Because these researchers identified reading by analogy as an indication of alphabetic understanding, their findings suggested that neither phonological awareness nor letter-sound correspondence was sufficient for acquisition of the alphabetic principle (i.e., phonological awareness, knowledge of the segmental structure of words, and letter-sound correspondence). What is important here is that these experiments were designed to show that not

knowing any part of the alphabetic principle can hinder acquisition of reading. As Byrne and Fielding-Barnsley (1989) stated:

> [T]he major hurdle for young learners in understanding the basic principle of alphabetic writing is the realization that the speech stream is composed of a small stock of interchangeable units, the phonemes. It is not sufficient to achieve this insight in order to discover the alphabetic principle as the child learns to read his or her first words. But explicit instruction in letter-phoneme relations, added to phonemic awareness, makes it likely that the child can compute the representational functions of those letters, whatever their position in otherwise unknown words...(p. 320)

Juel (1991) asserted logically that the "principal advantage" to an alphabetic language is the predictable correspondence between its graphemes and phonemes. This advantage is supported by mounting evidence that mastering these correspondences facilitates the transition from contextual guessing to efficient word recognition.

Area of Convergence #4: Word Recognition Mediated by Phonological Recoding

Torgesen (1985) described word recognition as a process involving the following steps:

> The phonological constituents of words must be obtained from their graphic representations, stored in sequence, and then blended together while the child searches memory for a real word that roughly matches the string of phonemes produced by the blending operations. (p. 354)

The prerequisites for word recognition may be enough for some children to make the link with very little guidance between the written word and its meaning (Ehri & Wilce, cited in Juel, 1991). For many children, however, more explicit instruction is necessary. Designing explicit instruction for word recognition requires deeper

understanding of the reading process. In the following section, we review research on the nature of phonological recoding and its role in word recognition.

Areas of Convergence for Skilled Readers

Beginning to recode and identify words. Early in reading acquisition, before children have mastered letter-sound correspondences, they focus primarily on context while attending to print only minimally (Juel, 1991). For example, if beginning readers read Goldilocks and the Three Bears, they may utilize beginning sounds, pictures, sight words, and story context to figure out unknown words such as "porridge" or "soft." This represents initial attempts at phonological recoding, the process of translating a printed word into its phonological counterpart via letter/sound rules (Daneman, 1991; Wagner & Torgesen, 1987). While for most readers this is just an initial attempt at phonological recoding, poor readers continue to use this inefficient and ineffective strategy when the task is to read independently.

As Ehri (1991) suggested, initial phonological recoding, which involves recoding letter strings into their corresponding sounds and blending the stored sounds into words, begins very overtly and slowly. As children learn to distinguish each sound, they begin, sometimes laboriously, to decode written words by attending to every letter. Chall (cited in Juel, 1991) agreed,

> [B]eginners...have to engage, at least temporarily, in what appears to be less mature reading behavior--becoming glued to print--in order to reach the real maturity later. They have to know about the print in order to leave the print. (p. 771)

Juel (1991) cited five studies suggesting that children begin to slowly and overtly decode words independent of formal reading instruction. While the "glued to print" approach is not a desirable way to read, it seems to occur naturally as children transition from letter-sound correspondence to word recognition.

Phonetic recoding versus phonological recoding. Some researchers interested in reading and memory have termed the first two steps of phonological recoding, namely, recoding the letters into sounds and storing them in short-term memory, "phonetic recoding." They hypothesize that efficient phonetic recoding is critical if beginning readers are to use minimal cognitive resources on the storage of letter sounds and maximum cognitive resources on actually blending the sounds to form words (e.g., Torgesen, 1985; Vellutino & Scanlon, 1987; Wagner, 1986).

Several longitudinal correlational studies examined the effect of efficient phonetic recoding on reading acquisition (Mann & Liberman, Mann cited in Wagner, 1986; Wagner & Torgesen, 1987). According to Wagner and Torgesen (1987), these results support their hypothesis that phonetic recoding plays a causal role in reading acquisition. Perhaps, as phonetic recoding becomes more efficient, beginning readers become better at blending the phonemes together to make words. Wagner and Torgesen (1987) cautioned, however, that no studies have measured reading skill while simultaneously tracking phonetic recoding skill. Thus, we do not know if the relation between reading acquisition and efficient phonetic recoding is unidirectional or reciprocal.

Phonological recoding in lexical access. The manner in which skilled readers link the orthographic representation of a word with its meaning has generated a considerable amount of research and debate in recent years. In particular, the role of phonological recoding in mediating word recognition has been highly contentious. Phonological recoding can be illustrated with the following example; the word "sun" can be converted into its component graphemes (letters: s, u, n), which in turn can be translated into corresponding phonemes (/s/-/u/-/n/) and blended to create the phonological referent to "sun." Once the word has been recoded into its phonological representation (i.e., language equivalent), it can be matched with a

similar string of sounds in the reader's lexicon (stored vocabulary) (Torgesen, 1985; Wagner, 1986; Wagner & Torgesen, 1987).

While evidence of the importance of phonological recoding in initial reading acquisition is vast (see Stanovich, 1991), the exact nature of the role phonological recoding plays in word recognition is not so clear. Daneman (1991) described the differing theories about the role of phonological recoding as follows:

> Some theories propose that fluent readers access word meanings directly from the visual representation (Smith, 1971; Thibadeau, Just, & Carpenter, 1982); others argue for phonological recoding (Massaro, 1975; van Orden, 1987); and others for a dual route, with the visual route being faster and used for familiar words while the phonological route is slower and used for unfamiliar words (Coltheart, Davelaar, Jonasson, & Besner, 1977; McCusker, Hillinger, & Bias, 1981). (p. 514)

Stanovich (1991) dismissed the idea of a dual route for a more interactive model of word recognition:

> The older question was phrased in a very discrete manner. Phonological information was activated either before lexical access or subsequent to it. Such a conceptualization fails to capture the continuous and distributed nature of phonological processing within the word recognition module. Activation of phonological codes by visual letter codes appears to take place almost immediately after stimulus onset, and these phonological codes immediately begin activating word codes, thus contributing to the ongoing word recognition process. (p. 438)

Citing 16 independent studies, Stanovich (1991) noted that despite the controversy and varying theories, there is substantial evidence that phonological recoding is important for early reading acquisition. Therefore, the issue seems to be not

whether or not beginning readers utilize phonological recoding to access word meanings, but to what degree phonological recoding mediates word recognition.

Role of phonological recoding and automatic word recognition. Presumably, if a particular word is in a child's spoken vocabulary and then is encountered in text, the child can recode the orthographic representation into its phonological representation and subsequently access the word in the lexicon. Some reading theorists believe that once children begin to decode unknown words independently, the orthographic representation of words becomes closely associated with their semantic representation (e.g., Ehri & Wilce, cited in Juel, 1991). Others hypothesize that decoding becomes very rapid so as to appear automatic (e.g., Gough & Hillinger, cited in Juel, 1991). This disagreement on how word recognition becomes more automatic also has spawned models of dual access to word recognition; that is, some words can be recognized directly from their orthographic (printed) representation, while others can be accessed through rapid decoding.

Stanovich's (1991) research synthesis on word recognition attempted to clarify the dual-access dilemma by reporting a hypothesized model of word recognition (Perfetti, cited in Stanovich, 1991) that accommodates phonological recoding in lexical access, as well as more expeditious approaches to word recognition. When a reader encounters visual letter codes, phonological recoding appears to be immediately activated and, in turn, immediately activates word codes in the reader's vocabulary or lexicon. When word recognition is slow, as in the case of low-frequency words, phonological recoding is allowed to proceed to facilitate word recognition. In the case of high-frequency words, on the other hand, word recognition may occur before phonological recoding has even been fully activated.

Using an interactive model, Adams (1990) described word recognition as an interaction between orthographic, meaning, and phonological processors. Adams' model supports findings that phonological recoding is activated immediately upon

presentation of a word (Perfetti, Bell, & Delaney; Tannenhaus, Flanigan, & Seidenberg; Van Order, Johnston, & Hale; cited in Adams, 1990). Complete phonological recoding of a word may occur, however, either before or after the meaning of the word has been accessed. Adams (1990) explained that phonological recoding has an inverse relationship with the frequency of the words to be recognized in reading.

> [W]hen readers encounter a meaningful word that they have read many times before...the word's meaning and phonological image will also be evoked with near instantaneity. For texts consisting entirely of such highly familiar words, it follows that phonological translation might indeed be somewhat superfluous. (p. 160)

Because texts composed entirely of familiar words are uncommon, it is in the presence of less familiar words that phonological recoding becomes important. In sum, when orthographic activation is slow (i.e., the word and/or its parts are unfamiliar), the phonemes are activated and, thus, word recognition is mediated by phonological recoding. If the orthographic representation is familiar (i.e., high-frequency, familiar words), word meanings may be accessed before the phonological representations are fully activated. Therefore, the phonological access of the word may follow lexical access. Regardless of the model used to depict the word recognition process, the interaction of word frequency and phonological recoding speed appears to determine the automaticity of word recognition. Unlike the causal relation between phonological awareness and reading ability, difficulties in developing a measure that taps just phonological recoding makes it difficult to establish a similar relation (Wagner & Torgesen, 1987).

Questions persist regarding what unit becomes automatically recognized and by what process such automaticity occurs (i.e., recognition of the whole word, word

parts, or individual letters). However, increased speed in word recognition has obvious benefits. As Juel (1991) noted,

> Whatever the processing reason behind the increased speed with which words can be identified, the freedom from deliberate attention to word identification allows the child to attend more to meaning, to use contextual information to facilitate the construction of meaning, and to reflect more broadly upon the content that is read. (p. 767)

Juel (1991) cited eight studies on the automaticity of word recognition, concluding that "by second or third grade, children can recognize many words while their attention is focused on another task--a sign that word recognition is automatic" (p. 770).

The effect of orthographic sensitivity to word parts on word recognition speed has prompted considerable, yet somewhat divergent, research findings. Ehri's (1991) review of 16 studies revealed that orthographic sensitivity follows automatic phonological recoding skill and repeated reading of phonologically regular and irregular words sharing the same patterns. Other studies showed that skilled readers become sensitive to rule-governed word parts as opposed to word parts that occur frequently but do not adhere to alphabetic rules. Many researchers have reported that during the development of orthographic sensitivity, readers begin to read words by analogy (Marsh, Friedman, Welch, & Desberg; cited in Ehri, 1991). These findings have been refuted by other researchers who suggest that children can be trained to read by analogy even before they learn to decode words (Goswami; cited in Ehri, 1991). Both lines of research regarding word recognition by analogy have been criticized for their methodology.

Although the results of research on reading by analogy remain equivocal, numerous studies have established that children become orthographically sensitive around the second grade (e.g., Leslie & Thimke, cited in Ehri, 1991). Juel (cited in

Stanovich, 1991), for example, found that fifth graders' word recognition speed benefited from their sensitivity to orthographic patterns, while second graders were constrained more by the decodability of words. Ehri (1991) postulated that Juel's findings may show that frequency of exposure to words is not as critical as a reader's more advanced lexical knowledge of different words for increasing the speed of word recognition.

Areas of Convergence for Diverse Learners

What is it about word recognition that poses problems for diverse learners? Daneman (1991) commented that differences between good and poor readers are not perceptual, but involve accessing name or meaning codes for words. Likewise, correlations between reading ability and retrieval of word meanings are consistently low as if to suggest that speed of lexical access does not contribute largely to reading ability (Daneman, 1991). However, phonological recoding does appear to account for individual differences in reading ability both in young readers as well as adults (Jorm & Share, cited in Daneman, 1991; Stanovich, 1986).

Typically, pseudowords are used to measure readers' phonological recoding speed because they isolate the application of letter-sound correspondence and blending from word meaning. Indeed, the reading task on which good and poor readers differ the most is the pseudoword recognition task (Hogaboam & Perfetti; Perfetti & Hogaboam; Stanovich; cited in Wagner & Torgesen, 1987). Poor readers exhibit differential sensitivity to the structural and meaning attributes of printed words. Poor readers are more sensitive to word meanings than to word structures and are especially insensitive to the phonological attributes of words (Vellutino & Scanlon, 1987). The results of studies examining phonological recoding and reading ability strongly suggest that access to and manipulation of phonological codes prior to lexical access play important roles in word recognition. As for alphabetic understanding, recent primary research in the area of automatic word recognition is

limited. In the next section, we review two recent studies on increasing automaticity in word recognition.

Interventions for Building Automatic Word Recognition

Facility with phonological recoding is necessary for automatic word recognition and fluent reading. Primary research investigating methods for improving reading fluency has focused on various repeated reading techniques. In a study on the effects of a combination of repeated readings and explicit memory instructions on reading fluency and reading comprehension, Sindelar, Monda, and O'Shea (1990) found that readers at all skill levels improved their fluency and recall from an instructional level to a mastery level after three readings of the same text and explicit instructions to remember as much of the story as possible. Sindelar et al. (1990) noted that the effects were positive and comparable for students both with and without learning disabilities. To explain the effects of the repeated readings intervention, the researchers intimated that by increasing their fluency, student attention previously allocated to word recognition was directed or redirected to understanding the meaning of the text. These findings suggest that multiple readings of stories would benefit all students in the classroom.

Similarly, Weinstein and Cooke (1992) studied the effects of repeated readings on 100-word reading passages for students with learning disabilities, comparing a fixed-rate criterion (i.e., 90 correct words per minute) with a criterion based on a set number of fluency improvements (i.e., three improvements). All four subjects in their study experienced an average of 60% fluency gain. The fixed-rate criterion produced slightly higher gains but required an average of 17.5 rereadings, while the criterion of three improvements required an average of 8.2 rereadings. Thus, while both methods are effective, using a fixed-rate criterion is less efficient. Weinstein and Cooke concluded that setting the criterion at three fluency improvements also offered students the opportunity to move more quickly through a wider range of

materials, perhaps explaining the greater generalization of fluency to new material exhibited by students in the three fluency improvement group compared to students in the fixed-criterion group.

Summary

Our review of the research literature suggested that learning to read words is anything but natural. On the contrary, learning to read words requires integration of numerous complex processes. Successful acquisition of these complex processes appears to be incidental for some children, but for others it must be systematically and planfully taught.

Four main areas of convergence bear implications for word recognition:

- Reading comprehension and other higher order reading activities are dependent on strong word recognition.
- Strong word recognition requires learner understanding that (a) words can be "spoken" or "written," (b) print corresponds to speech, and (c) words are composed of phonemes.
- Alphabetic understanding (i.e., a reader's understanding that words are composed of graphemes and letter-sound correspondence) facilitates word recognition.
- Phonological recoding (i.e., translating a word into its phonological counterpart) combined with word frequency mediates word recognition.

The graphic depiction in Figure 2 likens aspects of beginning reading to the elements of a strong rope.

Insert Figure 2 about here

That is, the strength of reading, like a rope, is dependent on a number of factors: (a) the strength of the individual fibers, (b) strategic integration of the fibers, and (c) effective binding or connecting of the fibers.

First, it is critical that the fibers contributing to the rope, namely, prerequisites to word recognition (i.e., understanding the function of print and phonological awareness), alphabetic understanding, phonological recoding, and automaticity are robust, stable, and reliable. Next, the strength of the reading rope depends on strategic integration of the fibers. Throughout the process of learning to read, storyreading and demonstrations of the role of reading for enjoyment as well as more functional purposes should be integrated with learning to read independently. Once early readers are taught some letter-sound correspondence, they can learn to blend those sounds into simple words. Similarly, as children begin to blend sounds into words, the words can be put into sentences so children can read connected texts. This type of careful integration contributes to strong reading abilities. Finally, systematic, carefully monitored, and planfully sequenced instruction binds the individual fibers together to facilitate fluent reading.

Many students do not require the same level of instruction as many diverse learners do. Failing to ensure effective instruction in the prerequisites of reading, phonological recoding, automaticity, and fluency may put diverse learners at great pedagogical risk. For example, if efforts are not taken to train phonological recoding explicitly, many readers may not be able to read newly encountered words. Similarly, if fluency building is not emphasized, students may remain disfluent readers indefinitely. Ultimately, if we provide diverse learners with the tools and strategies for achieving automatic and fluent word recognition, we increase their chances for successful reading experiences.

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Secondary Sources

Authors	Dimension of Beginning Reading	Subjects	Purpose
Adams, 1990	General		Review of relevant research on developing reading and reading readiness capacities in young children.
Daneman, 1991	General	Pre-readers through adult readers; low- and normally-achieiving and reading disabled	Isolates the cognitive components of reading and considers which cognitive components contribute to individual differences.
Ehri, 1991	General	Primary and elementary; normally-achieving	Develops an explanation for reading success and describes three-phase course of reading development.
Juel, 1991	General	Preschool to 1st grade; normally-achieving	Summarizes theoretical models of reading acquisition and enumerates factors that move a child from prereading to reading.
Liberman & Liberman, 1990	General	Preschool and kindergartners; low- and normally-achieving	Explores two predominant views of reading instruction and their implications for reading problems.
Liberman, Shankweiler, & Liberman, 1991	Alphabetic principle		Describes the alphabetic principle, its role in reading acquisition, and instructional implications.

Secondary Sources

Authors	Dimension of Beginning Reading	Subjects	Purpose
Spector, in press	Phonemic awareness	Preschool and primary; low-achieving readers	Summarizes research on how instructional practices influence phonemic awareness and provides instructional recommendations for developing phonological abilities.
Stahl & Miller, 1989	Whole language; language experience	Kindergarten through 3rd grade	Examines effects of whole language and language experience approaches on beginning reading achievement; qualitative research synthesis.
Stanovich, 1991	Word recognition		Reviews literature on word recognition and explores the central role of word recognition in the reading process.
Stanovich, 1993	General		Reviews author's career in beginning reading research including phonological awareness and the debate between phonics and whole language.
Sulzby & Teale, 1991	Emergent literacy	1-7 years old	Reviews recent studies on the nature and course of young children's literacy learning and their implications.

Secondary Sources

Authors	Dimension of Beginning Reading	Subjects	Purpose
Torgesen, 1985	Memory processes	reading disabled	Reviews research on (a) the complexity and diversity of memory processes, (b) the relation between memory and general intelligence, and (c) the causal relation between memory disabilities and reading failure.
Wagner, 1986	Phonological processing	4-10 years old; pre-readers and learning disabled	Examines (a) the nature of phonological processing, (b) the causal relation between the development of phonological processing and reading acquisition, and (c) the effects of phonological training on children with reading disabilities.
Wagner & Torgesen, 1987	Phonological processing	3-7 years old; pre-readers	Investigates the reciprocal and causal roles between three types of phonological processing (i.e., awareness, recoding in lexical access, and recoding in working memory) and reading acquisition.

Primary Sources

Authors	Dimension of Beginning Reading	Subjects	Purpose; Experimental Design
Byrne & Fielding-Barnsley, 1989	Phonemic awareness/ Alphabetic principle	Preschool; prereaders	Determines what conditions will lead to acquisition of the alphabetic principle; multiple method.
Haskell, Foorman, & Swank, 1992	Onset-rime training	First grade; normally achieving	Compares the effects of onset-rime, phoneme, and whole word-level training on word reading accuracy; pre-post group design.
Lovett, Warren-Chaplin, Ransby, & Borden, 1990	Word recognition	Multiple ages (7-13 years old); learning disabled	Examines the effects of letter-sound instruction on the word recognition skills of disabled readers; pre-post group design.
Lundberg, Frost, & Peterson, 1988	Phonological awareness	Preschool through 2nd grade; normally achieving	Evaluates a phonological awareness training program focusing on (a) the effects of training before reading instruction, (b) the transfer of phonological awareness to new metalinguistic tasks, (c) the long-term effects of training on reading and spelling acquisition, and (d) the effects of training on general language competence; pre-post group design.

Primary Sources

Authors	Dimension of Beginning Reading	Subjects	Purpose; Experimental Design
Sawyer, 1992	Word recognition; segmentation of words and sentences	Grades 1-3; normally achieving	Investigates the relationship between language variables and measures of reading along the K-3 continuum; longitudinal design, path analysis.
Sindelar, Monda, & O'Shea, 1990	Fluency	Primary and elementary (K-5); normally achieving and learning disabled	Examines the effects of repeated readings on fluency and recall for instructional and mastery-level readers; factorial design.
Spector, 1992	Phonemic awareness; dynamic assessment	Kindergarten	Investigates the ability of dynamic assessment of phonemic awareness to predict progress in beginning reading; multiple regression.
Vellutino & Scanlon, 1987	Phonological coding/ Phonological awareness	Primary (K and 2nd grade) and intermediate (6th grade); normally-achieving and learning disabled	Examines the causal relation between phonological coding deficits and reading disorders; correlational and pre-post group designs.
Weinstein & Cooke, 1992	Fluency	Primary and elementary (ages 7-10); learning disabled	Compares the effectiveness of two repeated reading procedures on fluency; multitreatment, single-subject design (ABACA).

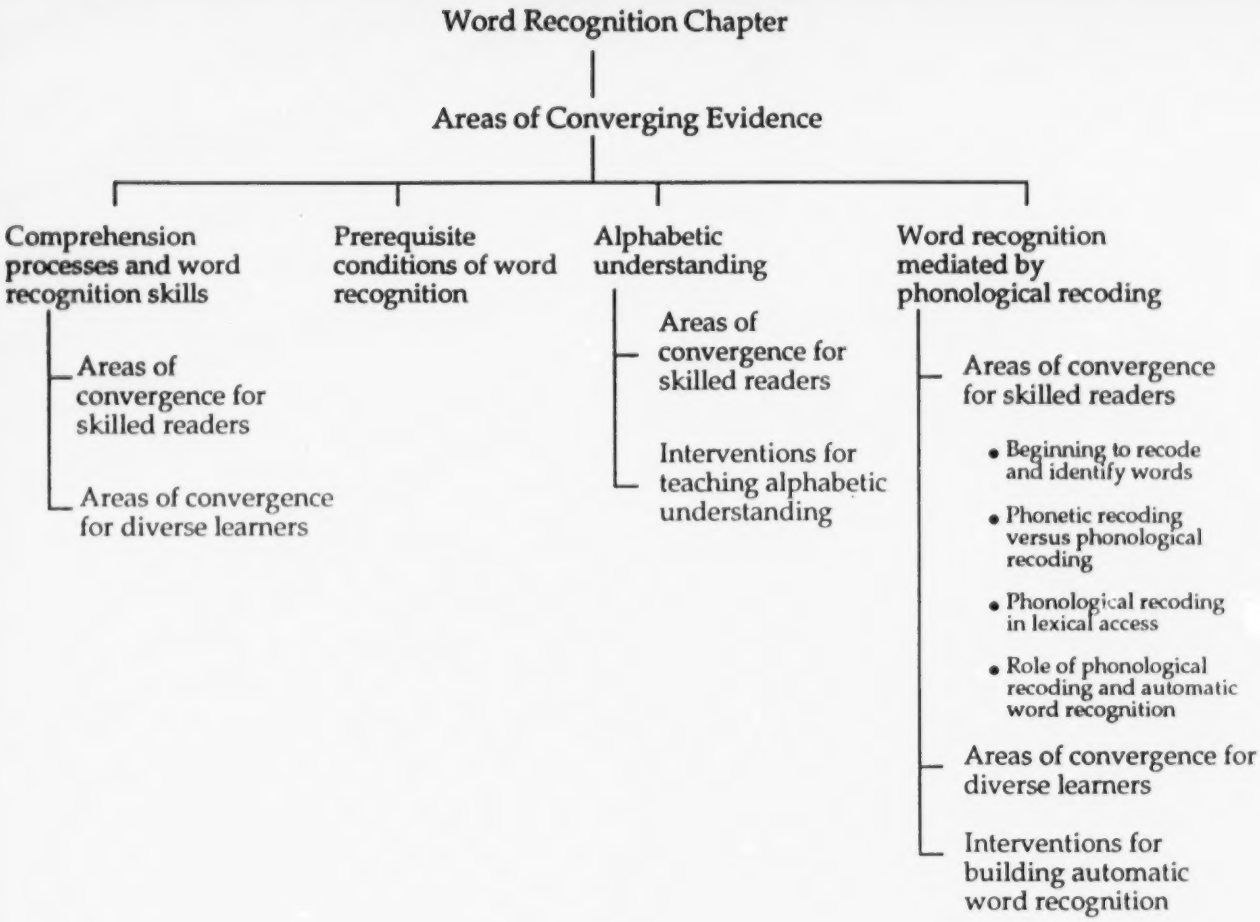
Primary Sources

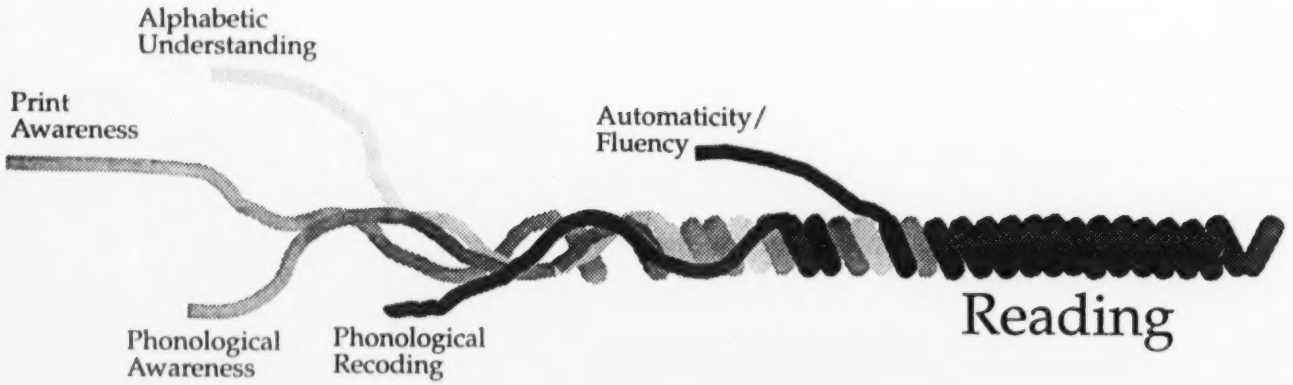
Authors	Dimension of Beginning Reading	Subjects	Purpose
Weir, 1989	Preschool literacy	Preschool (ages 3-4); normally achieving	Examines current opinion on the most appropriate means of enhancing understanding about print.

Figure Captions

Figure 1. Graphic depiction of the chapter structure.

Figure 2. Integration of word recognition components in reading.


Word Recognition Chapter
Areas of Converging Evidence
Comprehension processes and word recognition skills
Areas of convergence for skilled readers
Areas of convergence for diverse learners
Prerequisite conditions of word recognition
Alphabetic understanding
Areas of convergence for skilled readers
Interventions for teaching alphabetic understanding
Word recognition mediated by phonological recoding
Areas of convergence for skilled readers
• Beginning to recode and identify words
• Phonetic recoding versus phonological recoding
• Phonological recoding in lexical access
• Role of phonological recoding and automatic word recognition
Areas of convergence for diverse learners
Interventions for building automatic word recognition


Alphabetic
Understanding
Print
Awareness
Automaticity/
Fluency
Reading
Phonological
Awareness
Phonological
Recoding